

CLAIM AMENDMENTS

1 1. (Currently amended) A method of determining a placement of services of a
 2 distributed application onto nodes of a distributed resource infrastructure
 3 comprising the steps of:
 4 a. establishing a placement indicator for a specific service;
 5 b. forming communication constraints between node pairs which ensure that
 6 a sum of transport demands between a particular node pair does not exceed a
 7 transport capacity between the particular node pair, each term of the sum
 8 comprising a product of a first placement variable, a second placement
 9 variable, and the transport demand between the services associated with the
 10 first and second placement variables;
 11 c. forming an objective; and
 12 d. employing a local search solution to solve an integer program comprising
 13 the placement indicator, the communication constraints, and the objective to
 14 determine the placement of the services onto the nodes.

1 2. (Original) The method of claim 1 wherein the placement indicator
 2 comprises a pre-defined placement.

1 3. (Original) The method of claim 2 wherein the pre-defined placement
 2 comprises placing the specific service onto a specific node.

1 4. (Original) The method of claim 2 wherein the pre-defined placement
 2 comprises not placing the specific service onto a specific node.

1 5. (Original) The method of claim 1 wherein the placement indicator
 2 comprises a neutral indication of whether the specific service is to be placed onto
 3 a specific node.

1 6. (Currently amended) A method of determining a placement of services of a
 2 distributed application onto nodes of a distributed resource infrastructure
 3 comprising the steps of:
 4 a. establishing an application model of the services comprising transport

- 5 demands between the services;
- 6 b- establishing an infrastructure model of the nodes comprising transport
- 7 capacities between the nodes;
- 8 e- establishing a placement model comprising placement indicators for the
- 9 services;
- 10 d- forming an integer program that comprises:
 - 11 i- a set of placement variables for a combination of the services and the
 - 12 nodes, each of the placement variables indicating whether a particular
 - 13 service is located on a particular node;
 - 14 ii- communication constraints between node pairs which ensure that a
 - 15 sum of the transport demands between a particular node pair does not
 - 16 exceed the transport capacity between the particular node pair, each term
 - 17 of the sum comprising a product of a first placement variable, a second
 - 18 placement variable, and the transport demand between the services
 - 19 associated with the first and second placement variables;
 - 20 iii- placement constraints for the services which ensure that the services
 - 21 are placed onto the nodes in accord with the placement indicators; and
 - 22 iv- an objective; and
 - 23 e- employing a local search solution to solve the integer program which
 - 24 determines the placement of the services onto the nodes.

1 7. (Original) The method of claim 6 wherein a particular placement indicator
2 comprises an indication that a specific service is to be placed onto a specific node.

1 8. (Original) The method of claim 6 wherein a particular placement indicator
2 comprises an indication that a specific service is not to be placed onto a specific
3 node.

1 9. (Original) The method of claim 6 wherein a particular placement indicator
2 comprises a neutral indication of whether a specific service is to be placed onto a
3 specific node.

1 10. (Original) The method of claim 9 wherein a default for the placement
2 indicators comprises the neutral indication.

- 1 11. (Currently amended) A method of determining a placement of services of a
2 distributed application onto nodes of a distributed resource infrastructure
3 comprising the steps of:
- 4 ~~a.~~ establishing an application model of the services that comprises processing
5 demands for the services, storage demands for the services, and transport
6 demands between the services;
 - 7 ~~b.~~ establishing an infrastructure model of the nodes that comprises processing
8 capacities for the nodes, storage capacities for the nodes, and transport
9 capacities between the nodes;
 - 10 ~~c.~~ establishing a placement model comprising placement indicators for the
11 services;
 - 12 ~~d.~~ forming an integer program that comprises:
 - 13 ~~i.~~ a set of placement variables for a combination of the services and the
14 nodes, each of the placement variables indicating whether a particular
15 service is located on a particular node;
 - 16 ~~ii.~~ processing constraints which ensure that a sum of the processing
17 demands for each of the nodes does not exceed the processing capacity for
18 the node;
 - 19 ~~iii.~~ storage constraints which ensure that a sum of the storage demands for
20 each of the nodes does not exceed the storage capacity for the node;
 - 21 ~~iv.~~ first placement constraints which ensure that each of the services is
22 placed on one and only one node;
 - 23 ~~v.~~ second placement constraints which ensure that the services are placed
24 onto the nodes in accord with the placement indicators;
 - 25 ~~vi.~~ communication constraints between node pairs which ensure that a
26 sum of the transport demands between a particular node pair does not
27 exceed the transport capacity between the particular node pair, each term
28 of the sum comprising a product of a first placement variable, a second
29 placement variable, and the transport demand between the services
30 associated with the first and second placement variables; and
 - 31 ~~vii.~~ an objective of minimizing communication traffic between the nodes
32 and balancing processing loads on the nodes; and
 - 33 ~~e.~~ employing a local search solution to solve the integer program which

34 determines the placement of the services onto the nodes.

1 12. (Currently amended) A computer readable memory comprising computer
2 code for directing a computer to make a determination of a placement of services
3 of a distributed application onto nodes of a distributed resource infrastructure, the
4 determination of the placement of the services onto the nodes comprising the steps
5 of:

- 6 ~~a.~~ establishing a placement indicator for a specific service;
- 7 ~~b.~~ forming communication constraints between node pairs which ensure that
8 a sum of transport demands between a particular node pair does not exceed a
9 transport capacity between the particular node pair, each term of the sum
10 comprising a product of a first placement variable, a second placement
11 variable, and the transport demand between the services associated with the
12 first and second placement variables;
- 13 ~~c.~~ forming an objective; and
- 14 ~~d.~~ employing a local search solution to solve an integer program comprising
15 the placement indicator, the communication constraints, and the objective to
16 determine the placement of the services onto the nodes.

1 13. (Original) The computer readable memory of claim 12 wherein the
2 placement indicator comprises a pre-defined placement.

1 14. (Original) The computer readable memory of claim 13 wherein the pre-
2 defined placement comprises placing the specific service onto a specific node.

1 15. (Original) The computer readable memory of claim 13 wherein the pre-
2 defined placement comprises not placing the specific service onto a specific node.

1 16. (Original) The computer readable memory of claim 12 wherein the
2 placement indicator comprises a neutral indication of whether the specific service
3 is to be placed onto a specific node.

1 17. (Currently amended) A computer readable memory comprising computer
2 code for directing a computer to make a determination of a placement of services

3 of a distributed application onto nodes of a distributed resource infrastructure, the
 4 determination of the placement of the services onto the nodes comprising the steps
 5 of:

6 a. establishing an application model of the services comprising transport
 7 demands between the services;

8 b. establishing an infrastructure model of the nodes comprising transport
 9 capacities between the nodes;

10 c. establishing a placement model comprising placement indicators for the
 11 services;

12 d. forming an integer program that comprises:

13 i. a set of placement variables for a combination of the services and the
 14 nodes, each of the placement variables indicating whether a particular
 15 service is located on a particular node;

16 ii. communication constraints between node pairs which ensure that a
 17 sum of the transport demands between a particular node pair does not
 18 exceed the transport capacity between the particular node pair, each term
 19 of the sum comprising a product of a first placement variable, a second
 20 placement variable, and the transport demand between the services
 21 associated with the first and second placement variables;

22 iii. placement constraints for the services which ensure that the services
 23 are placed onto the nodes in accord with the placement indicators; and

24 iv. an objective; and

25 e. employing a local search solution to solve the integer program which
 26 determines the placement of the services onto the nodes.

1 18. (Original) The computer readable memory of claim 17 wherein a
 2 particular placement indicator comprises an indication that a specific service is to
 3 be placed onto a specific node.

1 19. (Original) The computer readable memory of claim 17 wherein a
 2 particular placement indicator comprises an indication that a specific service is not
 3 to be placed onto a specific node.

1 20. (Original) The computer readable memory of claim 17 wherein a

2 particular placement indicator comprises a neutral indication of whether a specific
3 service is to be placed onto a specific node.

1 21. (Original) The computer readable memory of claim 20 wherein a default
2 for the placement indicators comprises the neutral indication.

1 22. (Original) The computer readable memory of claim 20 wherein a matrix is
2 specified which expresses constraints or preferences for identifying a placement of
3 services onto nodes.

1 23. (Currently amended) A computer readable memory comprising computer
2 code for directing a computer to make a determination of a placement of services of a
3 distributed application onto nodes of a distributed resource infrastructure, the
4 determination of the placement of the services onto the nodes comprising the steps of:
5 a. establishing an application model of the services that comprises processing
6 demands for the services, storage demands for the services, and transport
7 demands between the services;
8 b. establishing an infrastructure model of the nodes that comprises processing
9 capacities for the nodes, storage capacities for the nodes, and transport
10 capacities between the nodes;
11 c. establishing a placement model comprising placement indicators for the
12 services;
13 d. forming an integer program that comprises:
14 i. a set of placement variables for a combination of the services and the
15 nodes, each of the placement variables indicating whether a particular
16 service is located on a particular node;
17 ii. processing constraints which ensure that a sum of the processing
18 demands for each of the nodes does not exceed the processing capacity for
19 the node;
20 iii. storage constraints which ensure that a sum of the storage demands for
21 each of the nodes does not exceed the storage capacity for the node;
22 iv. first placement constraints which ensure that each of the services is
23 placed on one and only one node;
24 v. second placement constraints which ensure that the services are placed

- 25 onto the nodes in accord with the placement indicators;
- 26 ~~vi.~~ communication constraints between node pairs which ensure that a
- 27 sum of the transport demands between a particular node pair does not
- 28 exceed the transport capacity between the particular node pair, each term
- 29 of the sum comprising a product of a first placement variable, a second
- 30 placement variable, and the transport demand between the services
- 31 associated with the first and second placement variables; and
- 32 ~~vii.~~ an objective of minimizing communication traffic between the nodes
- 33 and balancing processing loads on the nodes; and
- 34 ~~e.~~ employing a local search solution to solve the integer program which
- 35 determines the placement of the services onto the nodes.